# Reverse Water Gas Shift Reaction

The reverse water gas shift reaction (RWGS) is a method of producing water from carbon dioxide and hydrogen in the mechanism below.

CO2 + H2 🡪 CO + H2O ΔH = 9 kcal/mole

In the context of life support systems for a Mars Station it has been proposed that the RWGS reaction combined with a process to gain oxygen from water, possibly electrolysis, can be used to produce oxygen. The reactor needed is simply a pipe filled with catalyst, and is very similar to a Sabatier Reactor. The flow diagram below shows the process if the RWGS reaction is combined with electrolysis. The unreacted, excess hydrogen can be recovered after the reactor and the rest can be recovered after electrolysis. H2 is only lost through leakages so can theoretically be fully recycled.

The water is separated off using a condenser to remove the vapour and the remaining gases (CO, H2 and any unreacted CO2) are passed through a membrane separator. The CO2 and H2 components are recycled back into the reactor and the CO is either vented or stored for use in a different process. Pioneer Astronautics conducted experiments on the RWGS reaction and found that a conversion of nearly 100% could be achieved when a silica/copper catalyst was used at 350C, 0.2 bar and with a CO2/H2 ratio of 1:3.

A large disadvantage with this method of oxygen production is that half of all oxygen molecules are lost in the carbon monoxide produced. Because the carbon dioxide available (at this step) is limited if Martian resources are not utilised, this means that a resupply of oxygen would be required from Earth. The table below shows the total costs of transporting all required oxygen from earth every 18 months, and the costs of transporting the oxygen needed to supplement that produced in the RWGS reaction

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Over 18 months | Total Resupply | | Resupply Required with RWGS | |
| Weight (kg) | Cost | Weight (kg) | Cost |
| Minimum Oxygen Required | 4687 | £4.69 billion | 2343.5 | £2.34 billion |
| With 25% Safety | 5859 | £5.86 billion | 2929.5 | £2.93 billion |

Although savings are made with this method, the cost of resupply is still higher than in the Sabatier Reaction.